IBM Duomenų saugyklų naujienos

XiV Generation3

Storwize V7000 unified

3-tier Easy Tier

IBM Sprendimų diena
Vilnius 2011m. spalio 18d.

© 2011 IBM Corporation

Short history of disk drives…

- **System IBM 350 Disk Storage Unit – 14 September 1956**

5MB, 1200 rpm, service time <1 sec.

Total time required to random read all data with IOsize=512 Bytes ?

5 MB / 512 B ≈ 10.000 IO
(less then 3 hours)

© 2011 IBM Corporation

Modern disk drives

- **Seagate Cheetah ST3600057FC *)**
  - 4 plates, 15 Krpm
  - Sector size: 512 Bytes
  - Total capacity:
    - 600 Giga bytes
  - Srvice time ≈ 5,6 ms

*) http://www.seagate.com/docs/pdf/pl-PL/datasheet/disc/ds_cheetah_15k_7.pdf

© 2011 IBM Corporation

Modern disk drives

- **Seagate Cheetah ST3600057FC *)**

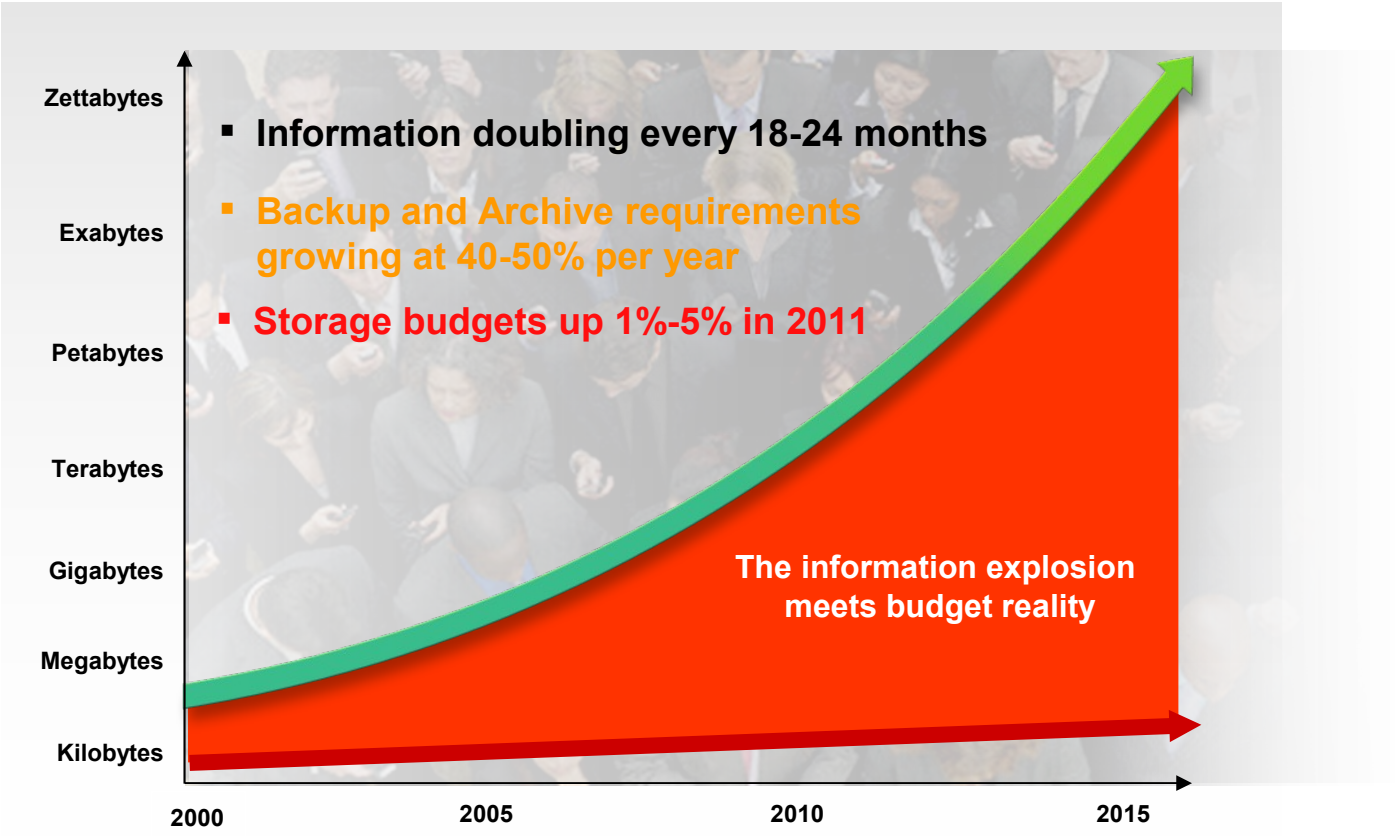
Total time required to random read all data with IOsize=512 Bytes ?

600 GB / 512 B ≈ 1.172 mln IO
(≈ 76 days)

*) http://www.seagate.com/docs/pdf/pl-PL/datasheet/disc/ds_cheetah_15k_7.pdf

© 2011 IBM Corporation

The Drivers of Our Business



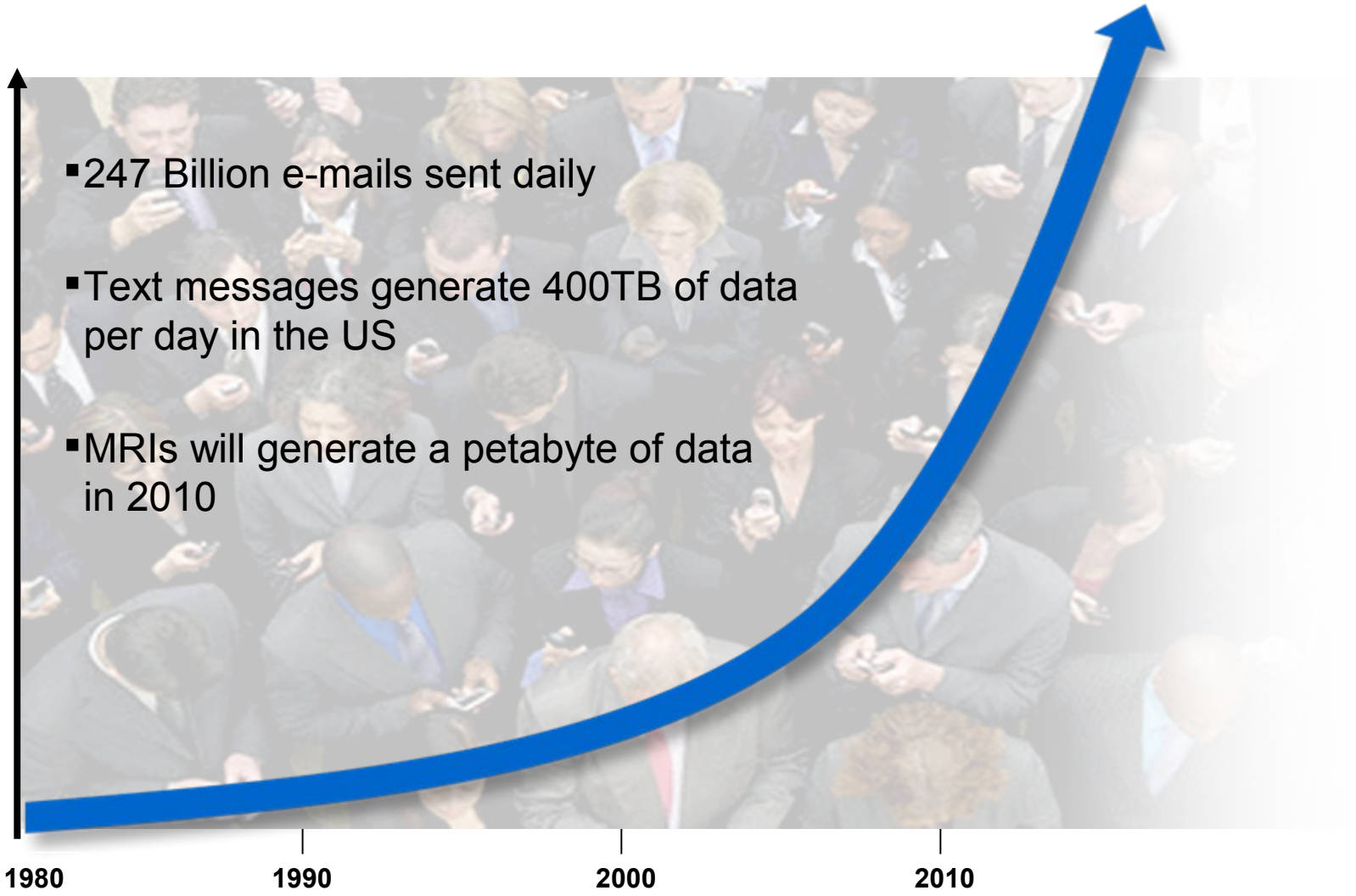
Business analytics has increased the value of information

The Cost of losing data and searching for it has skyrocketed

Users expect 100% availability of their applications and their information

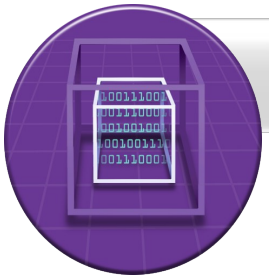
© 2011 IBM Corporation

Smarter Systems are Creating an Information Explosion


247 Billion e-mails sent daily
Text messages generate 400TB of data per day in the US
MRIs will generate a petabyte of data in 2010
1980
1990
2000
2010

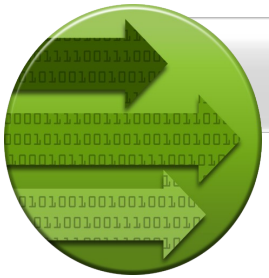
© 2011 IBM Corporation

Technology and best practices enable storage efficiency



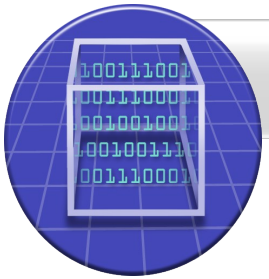
Stop Storing So Much

- IBM Real-time Compression … up to **80%** less space
- IBM ProtecTIER … up to **95%** smaller disk backups



Move Data to the Right Place

- IBM Easy Tier … **3X** more performance with **2% SSD**



Store More with What's On the Floor

- IBM Storage Virtualization … up to **30%** more utilization
- IBM Thin Provisioning … up to **35%** more utilization

© 2011 IBM Corporation

IBM Storage Portfolio as of 4Q2011

Entry/MidRange Storage Systems

- **Storwize Family**
  - V7000
  - V7000 Unified
- **DS Family**
  - DS5000
  - DS3000

Enterprise Storage Systems

- **DS8000 Family**
  - DS8700
  - DS8800
- **XIV Family**
  - XIV
  - XIV Gen3

File Storage Systems

- **Scale-Out NAS (SONAS)**
- **N Series**
  - N7000
  - N6000
  - N3000

Data Protection And Retention

- **TS Family**
  - TS7000
  - TS3000
  - TS2000
  - TS1000
- **ProtecTIER Deduplication**
- **Information Archive**

Efficiency "Enhancers"

- **Real-Time Compression**
- **Easy Tier**
- **SAN Volume Controller (SVC)**
- **Active Cloud Engine**

Storage Management Software

Tivoli software

- **FlashCopy Manager (FCM)**
- **Tivoli Productivity Center (TPC)**
- **Tivoli Storage Manager (TSM)**
- **Tivoli Key Lifecycle Manager**

© 2011 IBM Corporation

SAN Disk + NAS Portfolio 2010

SAN

DS3000 / DS4700	DS5000 / DS6800	V7000	XIV	DS8000
Entry-level	Midrange	Enterprise		

NAS

N3000	N6000	N7000	SONAS
Entry-level	Midrange	Enterprise	Ultrascalable

© 2011 IBM Corporation

A Consistent Drumbeat of Storage Efficiency Innovation

2010

Storwize V7000
- The most advanced mid-range storage
- Built-in storage efficiency

Easy Tier
- The most powerful and easiest auto tiering technology in the industry

Real-time Compression Appliance
- Reduce storage space requirements without degrading performance

DS8800
- Up to 40% better performance
- Up to 36% less energy consumption

2011

XIV Gen3
- Up to 69% lower TCO
- Up to 4 times faster

Linear Tape File System
- 2011 Pick Hit award, Broadcast Engineering

Real-time Compression Appliance
- Support for EMC storage, making even our competitors' storage more efficient

TS3500 Tape Library Connector
- Up to 2.7 Exabytes of low cost storage

© 2011 IBM Corporation

October 2011 Storage Announcements

Announcement letters released: Oct 11, ibm.com live: October 12, press release Oct 19

- **IBM® Storwize® V7000 Unified** - Integrated support for file storage, higher capacity drives, and more remote mirroring options (GA Nov 18)
- **IBM System Storage® DS8800** - Easy Tier™ enhancements, larger drives, and advanced IBM zEnterprise™ integration (GA Nov 18)
- **IBM XIV® Storage System Gen3** - High capacity 3TB drives, iPad management app (GA Nov 17)
- **IBM Scale Out Network Attach Storage (SONAS) R1.3** - Active Cloud Engine™ site-to-site replication, 3 TB drives, new easy to use GUI (GA Oct 21)
- **IBM SAN Volume Controller V6.3** - Stretched Cluster option extends distance up to 300km and Global Mirror adds low bandwidth option (GA Nov 20)
- **IBM Real-time Compression Appliances™** STN6500 and STN6800 V3.8 - Enhanced operational management, SMBv2 Windows protocol support (GA Oct 21, Dec 21 for SMBv2)
- **IBM System Storage EXP2500 Express®** - 900 GB drives, SSD, direct attach to BladeCenter® (GA Oct 28)
- **IBM System Storage N Series** – OnCommand 5.0, 600 GB drives with encryption (GA Nov 11)
- **IBM Tivoli® Storage Manager v6.3** - Hot standby disaster recovery management, more capacity and automated client agent updates (GA Oct 14)
- **IBM Tivoli Storage FlashCopy® Manager v3.1** - Support for Oracle, SAP and IBM DB2® running on HP/UX, file servers running Microsoft NTFS, and VMware (GA Oct 14)
- **IBM Tivoli Storage Manager for Virtual Environments v6.3** - VMware vCenter integration and support for hardware snapshots (Oct 21)
- **IBM Tivoli Storage Productivity Center** - Storage tiering reports. TPC Select adds site recovery management (GA Oct 14)

© 2011 IBM Corporation

Introducing XIV Gen3

Evolution of the Revolution

© 2011 IBM Corporation

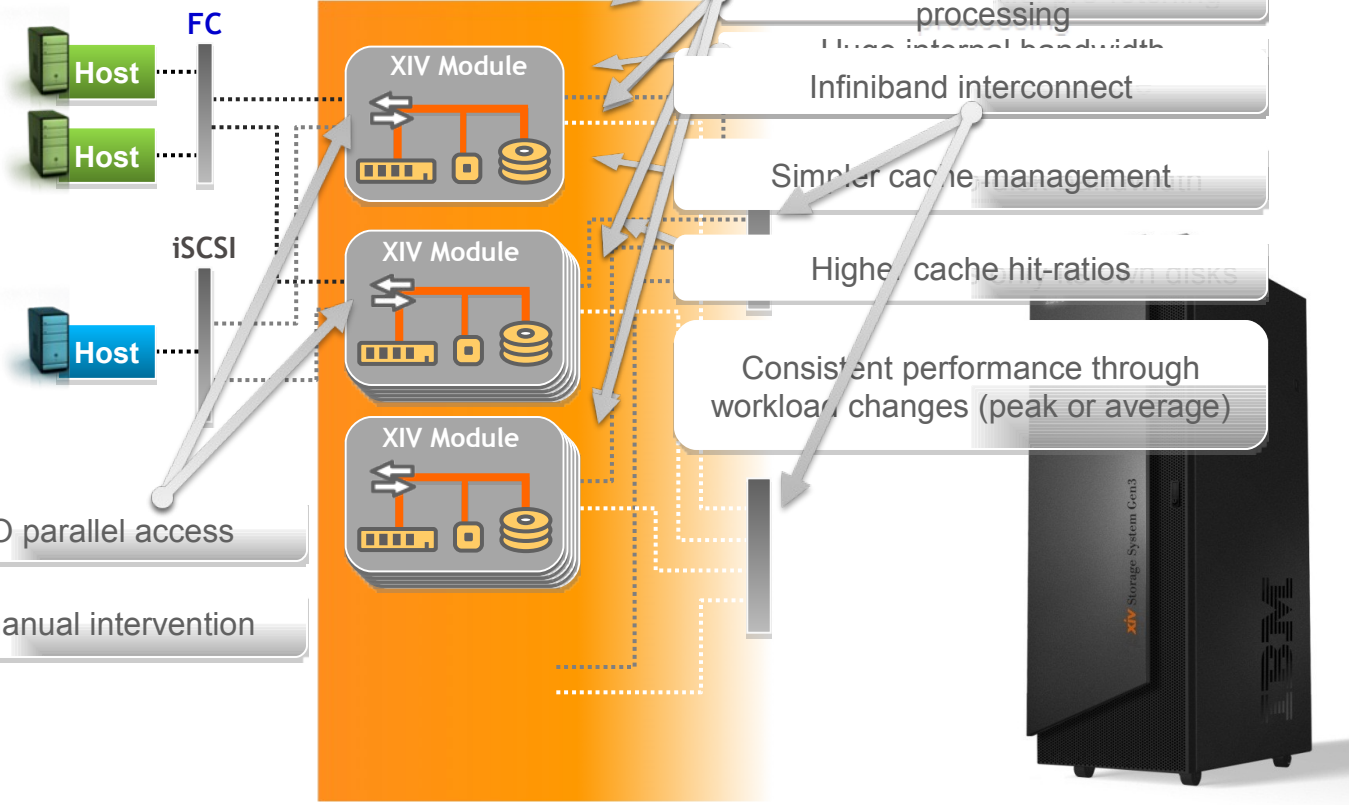
Architecture Review

Ground-breaking Architecture

- Large Processing Power (Modules)
- Grid Architecture
- Innovative and Powerful Caching

Other solutions…

- Clustered Controllers
- RAID protections
- Long RAID rebuilds
- Require LUN/Disk Layout
- Performance tuning
- Disk Hot-Spots
- Islands of storage



© 2011 IBM Corporation

Architecture Review

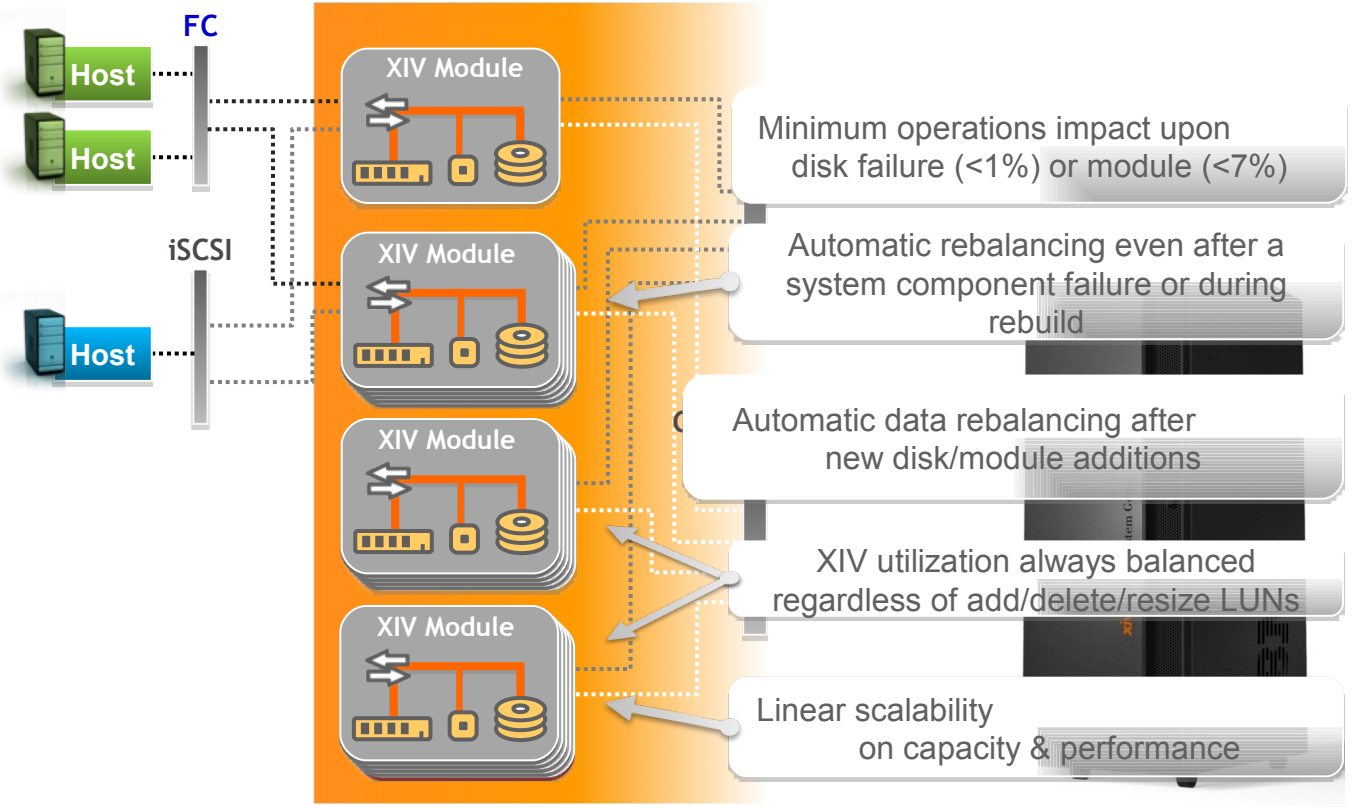
Ground-breaking Architecture

Scalable and sustained high performance

Unprecedented Resiliency

Other solutions…

- Manual intervention
- Redesign after changes
- Capacity-only scalability
- Performance tuning
- Continual data movement
- High impact after any failure

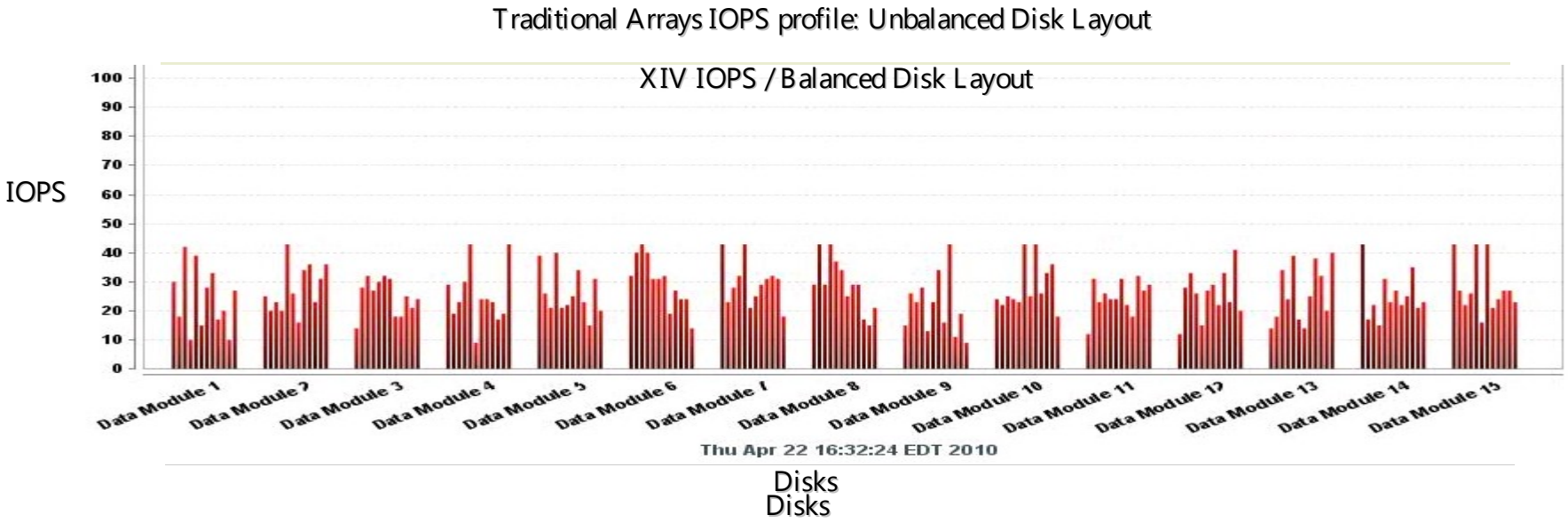


© 2011 IBM Corporation

Architecture Review: XIV vs Traditional Architecture Disk Utilization

We go to this… Not this…

- The result?



© 2011 IBM Corporation

IBM XIV Gen3 Technology Highlights

Smarter Storage, Built for Performance

- **20X more internal bandwidth**
  Using Infiniband
- **Over 2X more external bandwidth**
  With 8 Gbps FC ports and over 3x more iSCSI ports (6-22)
- **New motherboards and processors**
  2x disk bandwidth, 60 cores, 120 hyper-threads per rack.
- **50% more cache capacity**
  Up to 360GB/system, (24GB per module).
- **SSD ready**
  Optional cache upgrade of up to 7.5TB
- **3TB disks**
  50% capacity more, up to 240TB

© 2011 IBM Corporation

Kicking Off a Second Century of IBM Storage Innovation

Gen3 – *Evolution of the Revolution*

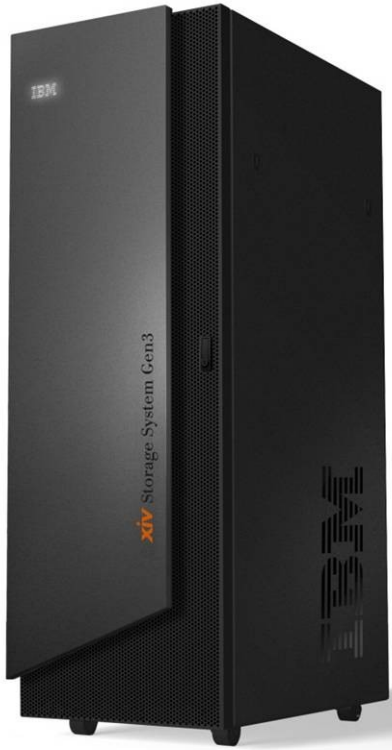
Gen2 Profile

- High performance
- Lower cost/TB
- Lower entry point
  - *27 TB usable*

Gen3 Profile

- Ultra-High Performance
  - *Up to 4X increase*
  - *SSD cache upgradeable*
- Higher entry point capacity
  - *55 TB usable*

- **20% less power consumption**
- **20% less heat output**
- **33% less noise reduction**

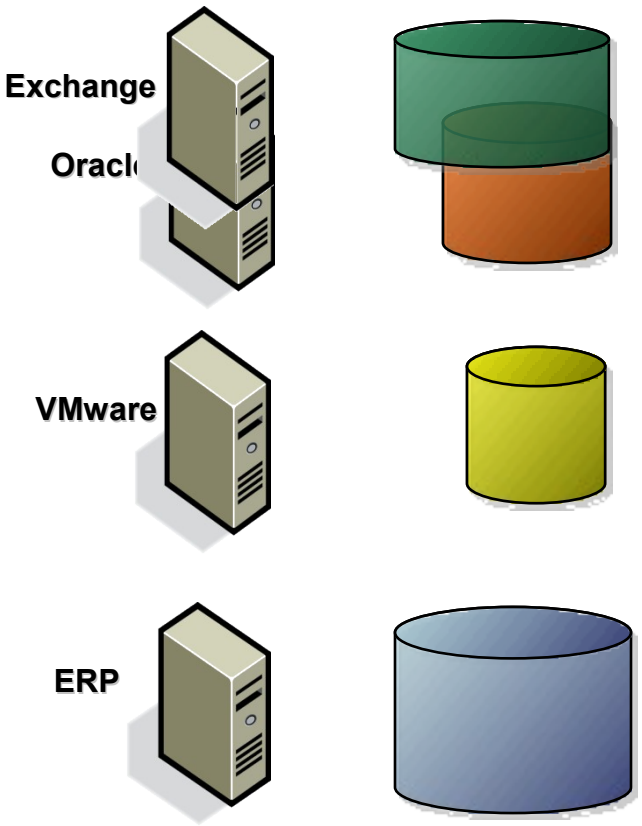


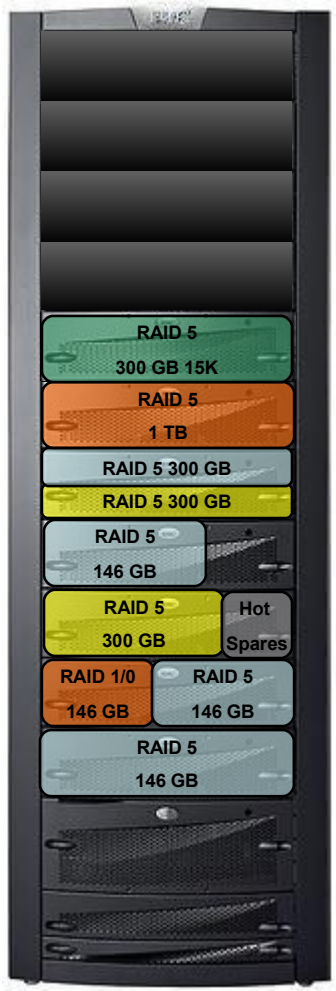
Both deliver…

- 60% lower TCO than competition
- Broad workload affinity
- Radical Simplicity
- Fully autonomic data placement, self-healing
- Advanced features out-of-the-box

© 2011 IBM Corporation

Architecture Review: ***Traditional*** Storage Distribution



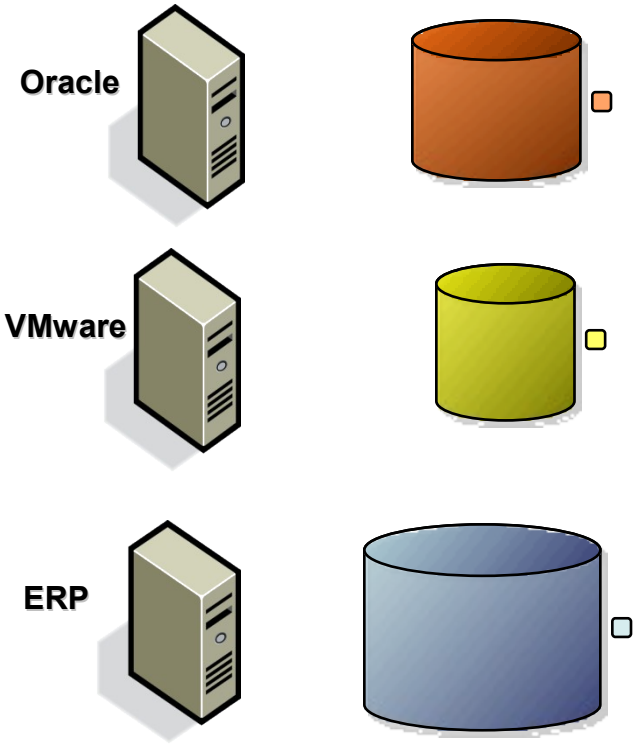


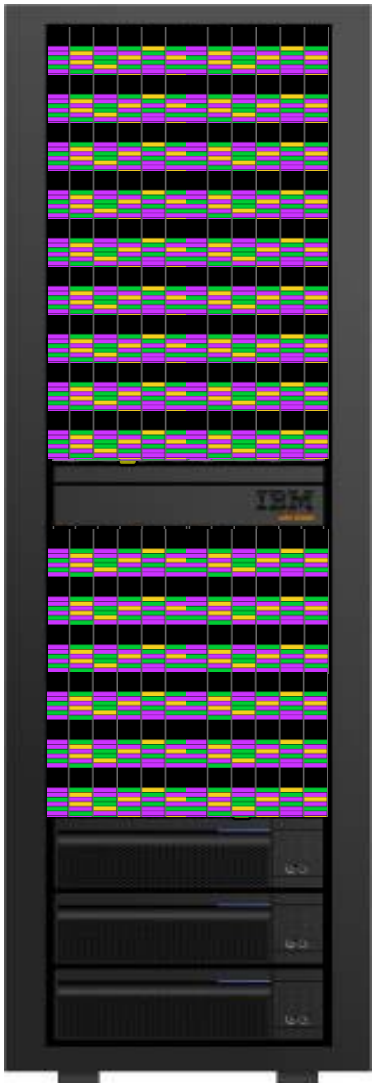
- Scalability is limited and not linear
- Hot-Spots and Performance issues require analysis, design and tuning
- Capacity is added but performance is reduced
- To improve performance, a redesign/relayout is required
- Lots of work to keep and maintain this array

© 2011 IBM Corporation

Architecture Review: XIV Storage Distribution

Ground-breaking Architecture





- Data is spread across all drives
- Even Disk utilization
- NO manual intervention
- No Tuning
- No Hot-Spots

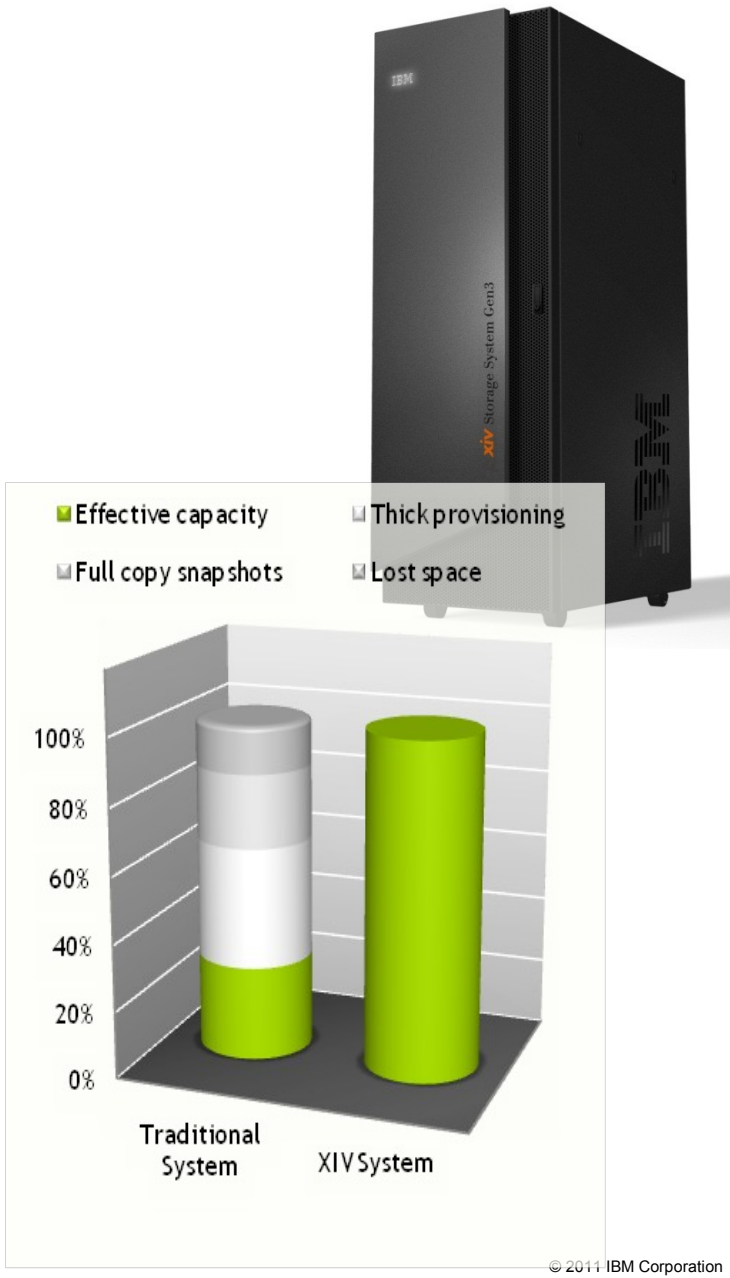
© 2011 IBM Corporation

Feature Summary

Powerful Features

Enterprise-class, Robust Features

- Unique **snapshot** technology
- Simple, dynamic **QoS**
- Powerful Synchronous and asynchronous **mirroring**
- Streamlined **data migration**
- Strong **host software** support
- Native **thin provisioning** with thick-to-thin migration
- Comprehensive **management** of events, statistics and performance
- Advanced **LDAP**-based authentication
- Secure role-based **access control**



© 2011 IBM Corporation

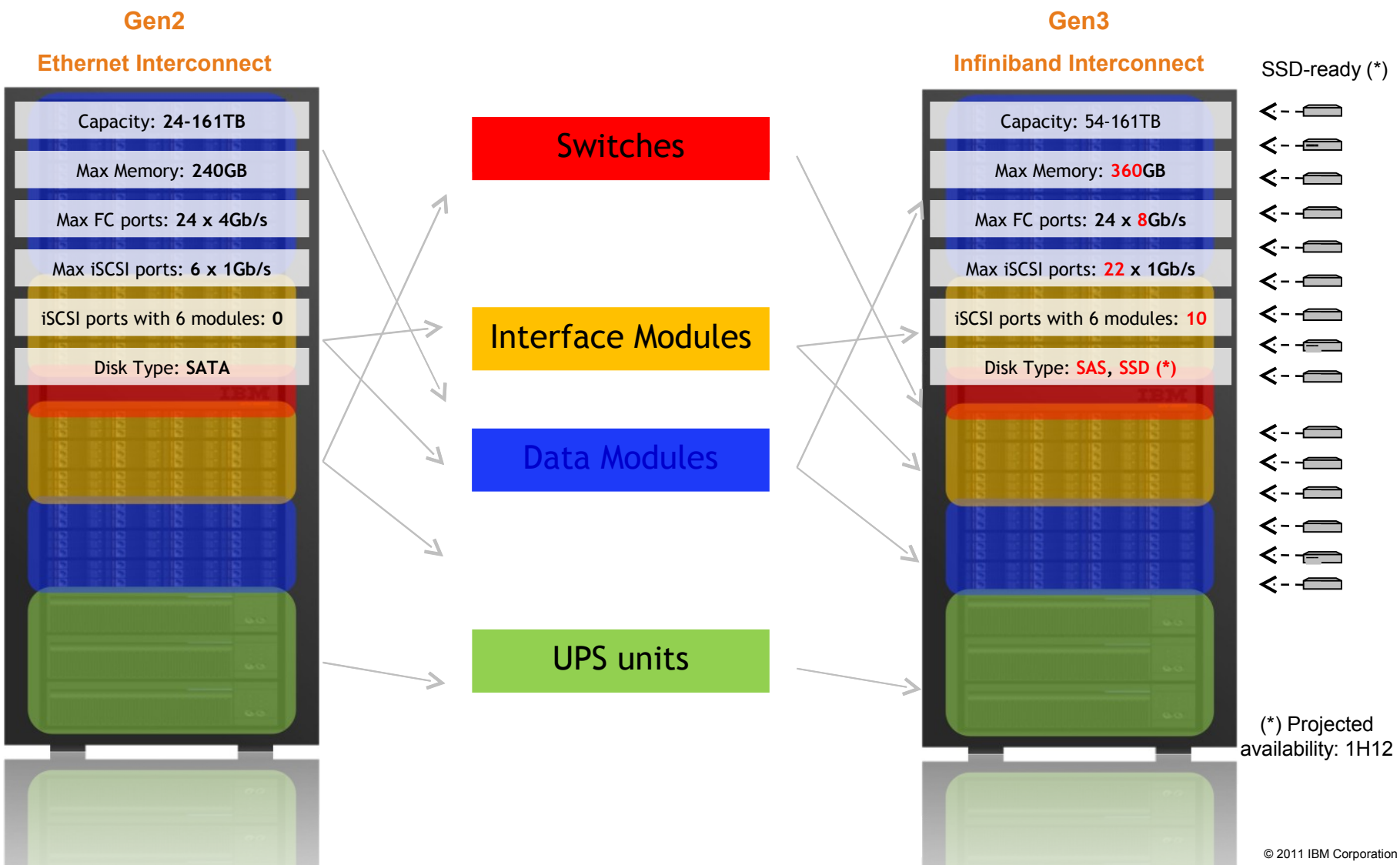
Radical Simplicity

Extreme Ease-of-Use

- Breakthrough GUI
- Exceptional ease of use
- Powerful management capabilities
- Easy, rapid provisioning
- Minimal administration
- Minimal training required

© 2011 IBM Corporation

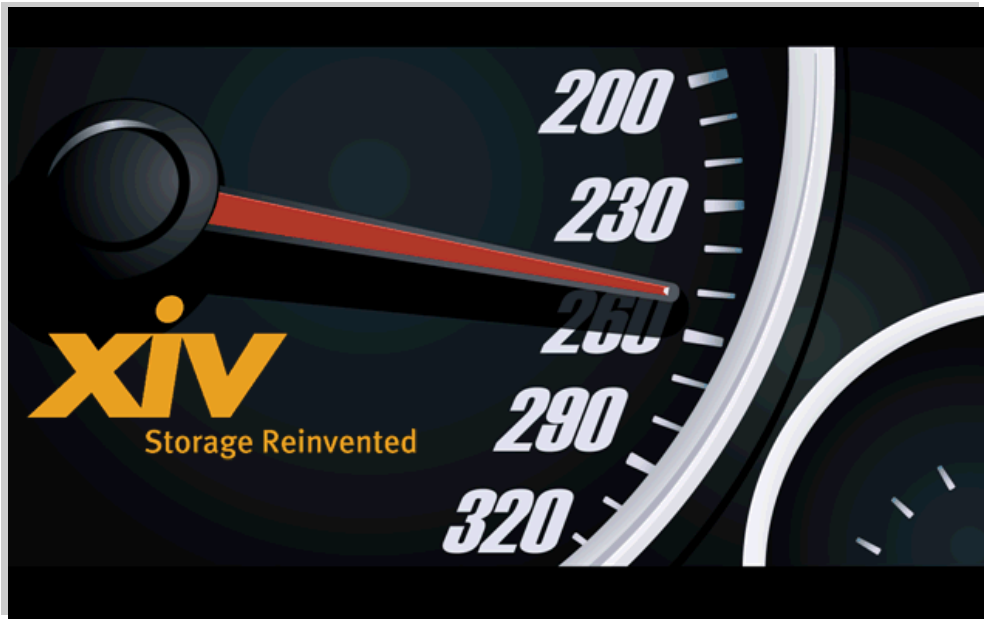
Enterprise-Ready, Smarter by Design



© 2011 IBM Corporation

Performance Review

Evolution of the Revolution



© 2011 IBM Corporation

Gen3 Performance Summary (con't)

Overall system improvements result in

- *higher performance and bandwidth*
- *Lower latency*
- *Significant improvement in OLTP environments*

- Up to **3x performance on read/write hit** loads:
- Up to **4x performance on sequential** loads:
- Up to **3x** lower latency

- RAW single threaded writes, **4x** increase
- RAW single threaded reads, **3x** increase

>500,000 IOPS (read, hits)

>10 GB/s (read)

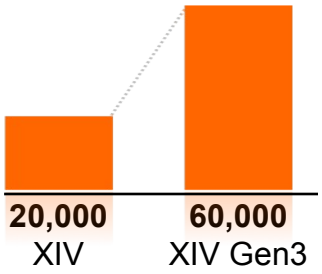
170 uSec single-io latency

© 2011 IBM Corporation

IBM XIV Family Delivers Outstanding Performance Across Applications

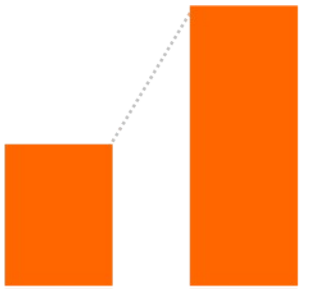
Microsoft Exchange Mailboxes

- 2 hour performance test
- Requires latency under 20 ms
- ESRP-Storage test



Oracle Data Warehouse (IOPS)

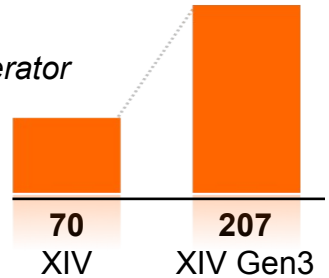
- Oracle DHW Workload



SAS Business Analytics Workload

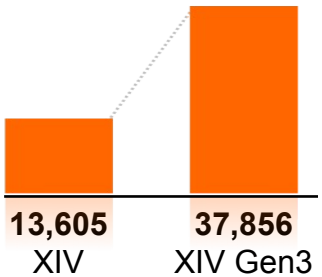
- Analytics reports created

Simulated via Swingbench load generator



Microsoft HyperV Simulation (IOPS)

- 200GB dataset
- 60% write activity



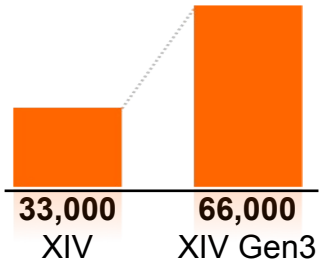
Performance is based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.

© 2011 IBM Corporation

IBM XIV Family Delivers Outstanding Raw Performance

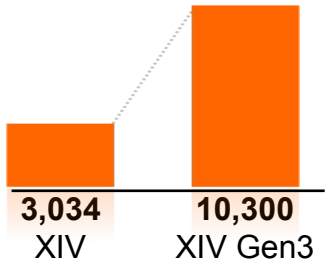
Transaction Processing (IOPS)

- Mixed read / write workload



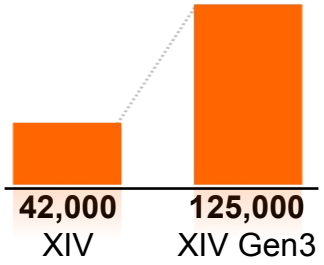
Sequential Reads (MB/sec)

- System Bandwidth



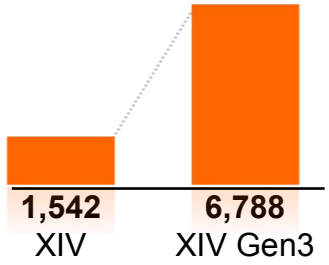
File and Print Services (IOPS)

- Mixed file size workload
- XIV Gen3 also had 50% lower latency



Sequential Writes (MB/sec)

- System Bandwidth

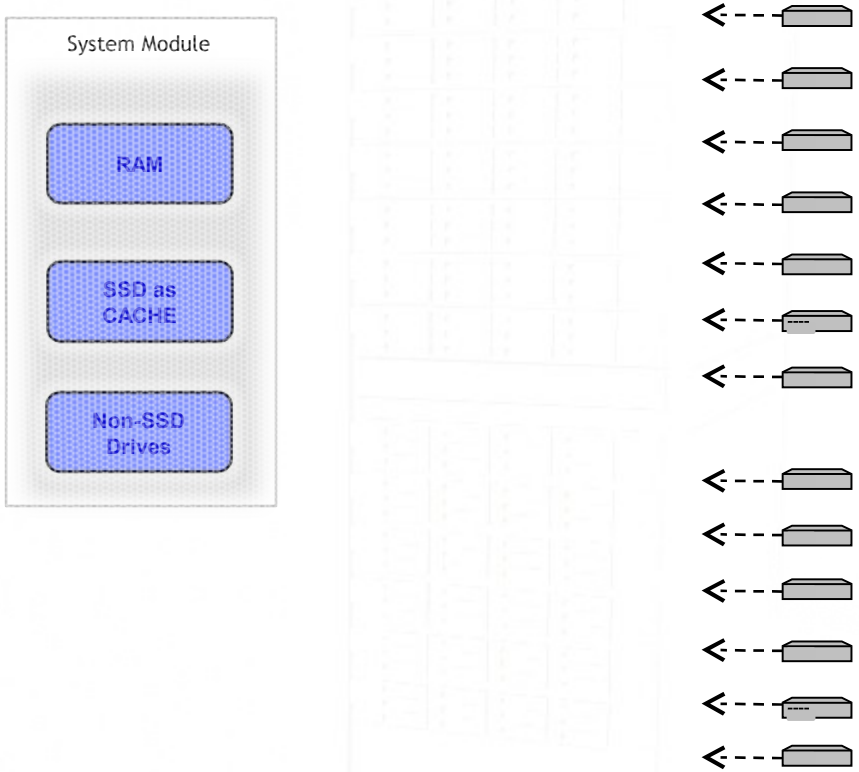


Performance is based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.

© 2011 IBM Corporation

Transparent XIV SSD Caching *

- Upgrade option: **SSD Caching**
  - SSD serves as a cache layer between RAM and SAS drives
  - Up to 7.5TB of fast cache
  - Simple, efficient
  - No separate disk tier to manage
- Designed to offer significant performance improvement for all usage profiles



(*) Projected availability: 1H12

© 2011 IBM Corporation

XIV Gen3 Enhancements

- **50% more capacity** – Integrates high capacity 3TB drives while maintaining consistently high application performance
- **Price Performance**
  - Exchange ESRP* results demonstrate 2 times better disk efficiency than EMC, HP, or HDS
  - New SPC-2 results (released later in October) will show exceptional throughput and the best price performance
- **IBM XIV Mobile Dashboard** – iPad app that monitors XIV from wherever you are - It doesn't get any easier

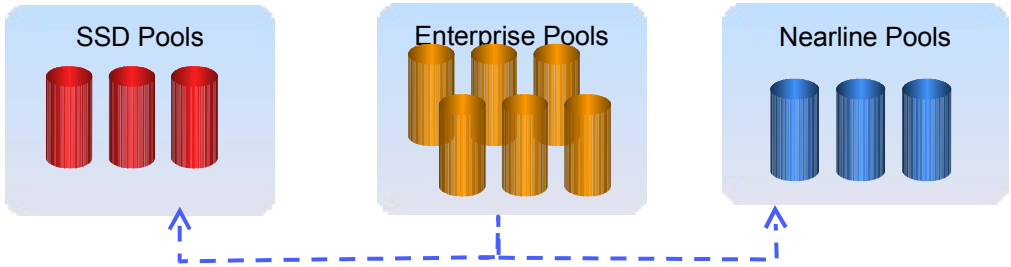
* Microsoft Exchange Solution Reviewed Program (ESRP). http://technet.microsoft.com/en-us/exchange/ff182054

Performance is based on measurements and projections using benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here. Disk efficiency is (#mailboxes * IOPS per mailbox / number of disks) * mailbox capacity, using vendor postings as of October 1, 2011

© 2011 IBM Corporation

3 Tier EasyTier & DS8800

- **Easy Tier** automatically balances data across 3 tiers so there is no tradeoff between cost and performance
- **Higher scalability** supports up to 45% more drives in only 33% more floor space
- **Large capacity 3 TB drives** almost triples overall capacity and supports data with moderate or varying performance requirements
- **System z functional synergy** simplifies volume management and enhances DB2 performance



IBM Confidential until announcement

© 2011 IBM Corporation

The IBM Storwize® V7000 has delivered unprecedented power, flexibility, ease-of-use and value to mid-range storage

© 2011 IBM Corporation

Now, only one year later, we're delivering the next major step forward in the evolution of IBM Storage

© 2011 IBM Corporation

Storwize V7000 Significant Milestones – 3Q11

- **Over 4,500 systems purchased world-wide since Nov 2010 GA**
  - Over 10,000 total enclosures deployed WW
  - Over 100 PB of capacity
- **Over 2,500 happy customers world-wide**
  - Presence in every major country and industry
  - Delivering five nines data availability
  - Over 1,000 net new storage customers
- **Over 40 WIN flashes published**
  - Competitive wins across every geo
  - Click here to find **additional Storwize Win Flashes** on w3
- **39 official references in customer database**
  - 10 added in September alone
- **One of the fastest product ramps up in IBM storage history**

© 2011 IBM Corporation

One Year Later: Technology Integration Continues
Storwize V7000 Delivers Unified Storage

Leveraging the best of IBM storage technologies in a midrange disk system

© 2011 IBM Corporation

We're bringing to market a powerful, flexible new midrange unified storage platform.

One that is actually… Unified.

© 2011 IBM Corporation

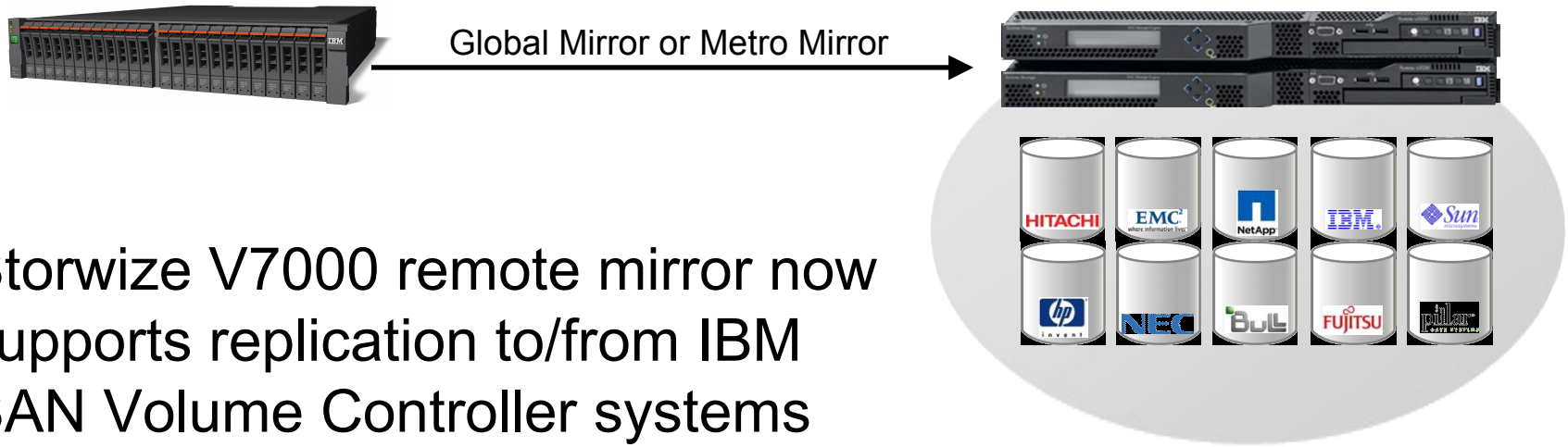
Storwize V7000

- **New Storwize V7000 Unified**
  - Unified block and file (SAN and NAS) storage
  - Upgradable from existing Storwize V7000 systems
  - IBM Active Cloud Engine policy-based management
- **Greater flexibility for remote mirror**
  - Replicate between Storwize V7000 and SVC
  - Balance remote data currency with network bandwidth cost to better meet application requirements
- **Additional drive options**
  - 200GB and 400GB SFF SSDs
  - 3TB LFF HDD
    - 50% greater maximum system capacity
- **Enhanced Tivoli Storage FlashCopy Manager support**
  - VMware vSphere 4 and vSphere 5
  - DB2, Oracle, and SAP on HP-UX

IBM Confidential until announcement

© 2011 IBM Corporation

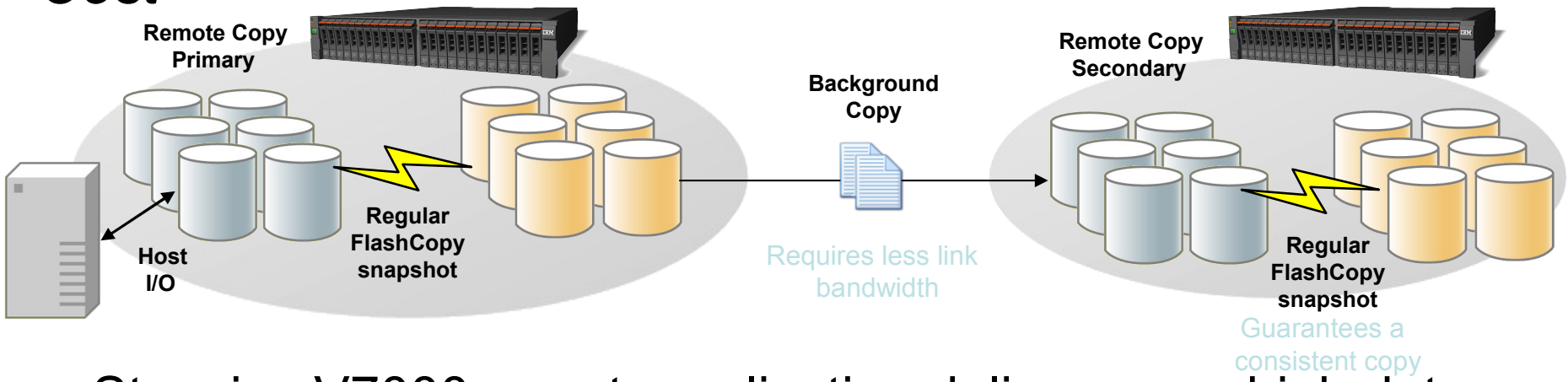
Greater Flexibility for Remote Mirror
Replication to Virtually Any Storage



- Storwize V7000 remote mirror now supports replication to/from IBM SAN Volume Controller systems
- Enables use of any storage supported by SVC as replication target for Storwize V7000
  - Over 130 different disk systems from all major vendors
- Provides new options to redeploy existing storage to extend life and

© 2011 IBM Corporation

Greater Flexibility for Block Data Remote Mirror
Balance Remote Data Currency With Network Bandwidth Cost



- Storwize V7000 remote replication delivers very high data currency at remote site but requires network bandwidth to support this currency
- New Global Mirror ***option*** makes regular copies of data at primary location and transmits them to secondary location
- User can select frequency of these copies, which determines network bandwidth required and data currency
- Provides much more flexibility to meet specific application

© 2011 IBM Corporation

Storwize V7000 Unified

What this is

- Unified storage system with tightly integrated management for both block and file capabilities
- Support for NFS/CIFS/FTP/HTTPS/SCP file protocols in addition to existing block functions (FCP and iSCSI)
- File replication and file level snapshots for business continuity and disaster recovery in addition to existing block functions

Why It Matters

- Convergence of even more workloads into one Storwize V7000 Unified system for greater storage efficiency
- Enables consolidation of multiple stand-alone file servers to reduce management effort
- Upgrade path for installed Storwize V7000 systems (planned availability 1H2012)
- Enables deployment of a broad set of applications from within a single storage system, especially in shared storage environments

© 2011 IBM Corporation

Storwize V7000 Unified Highlights

- Ordered in eConfig as a unified system
- Same control and expansion enclosures as Storwize V7000
- Two Storwize V7000 File Modules (2073-700) running Storwize V7000 File Module Software (5639-VF1)
- Minimum config 6U footprint comparable with EMC and NetApp unified midrange offerings

Software inherited from prior offerings plus enhancements

NEW **Unified storage management**

- Converged File/block GUI with Storwize V7000 ease-of-use
- Simplified installation based on Storwize USB key
- Coordinated RAS, event logs and error recovery
- ISV whitepapers for file workloads

Proven **IBM software functionalities**

- Storwize V7000 Block capabilities
  - Storage Efficiency Advanced SW Functions
  - Enterprise Block capabilities at a midrange price
  - Grows as your needs grow
- File capabilities as part of IBM's NAS family
  - NFS/CIFS/FTP/HTTPS/SCP
  - File replication and cloning, fileset level snapshots
  - NDMP and/or TSM Backup/Restore
  - ILM/HSM capabilities
  - Anti-virus support capabilities

© 2011 IBM Corporation

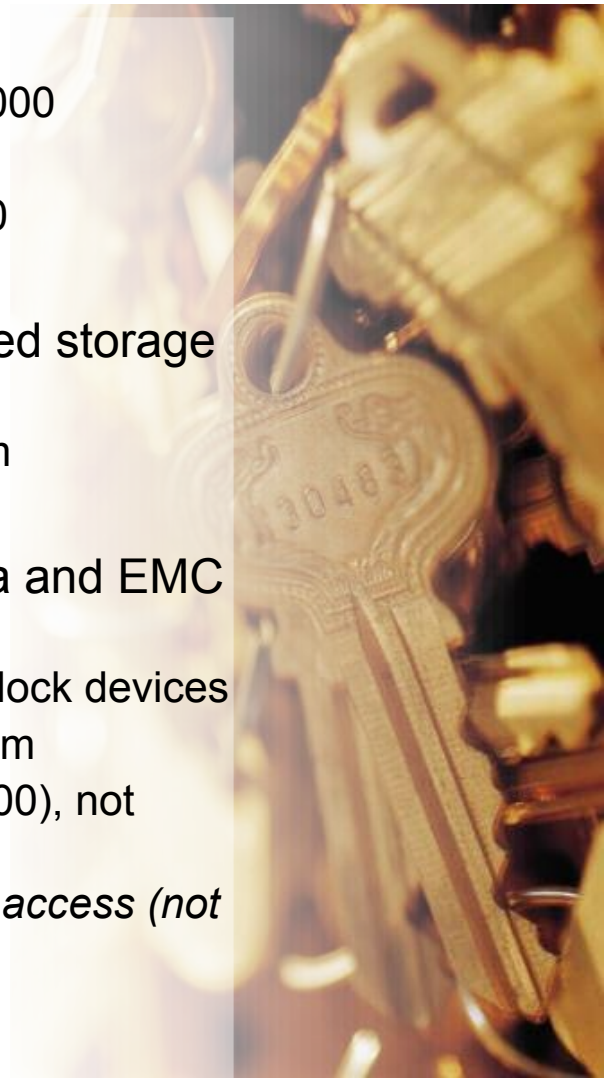
What's Different About Storwize V7000 Unified?

- ***Based on highly successful Storwize V7000 block storage system***
- Fully integrated user interface for block and file data simplifies management
  - Not a "unified" launcher for two different interfaces
- Simple USB key based initial setup: extends successful Storwize V7000 approach
- IBM Active Cloud Engine™ technology delivers automated storage efficiency capabilities
  - True policy-based management of files
  - With user-defined policies!
- Built-in IBM Tivoli Storage Manager client simplifies backup to TSM server
  - System also supports NDMP for third-party backup clients

© 2011 IBM Corporation

Storwize V7000 Unified Key Points

- Storwize V7000 Unified is a midrange disk system
  - Customer set-up and maintained: built on proven Storwize V7000
  - Intuitive GUI with wizards: built on proven Storwize V7000
  - Support call flow starts in the same manner as Storwize V7000
- Storwize V7000U is the first IBM-developed midrange unified storage offering
  - Presenting both file and block interfaces from the same system
- Storwize V7000U has a similar architecture to EMC Celerra and EMC VNX
  - Unified management, ordering, and support but separate file/block devices
  - File “module” hardware/software in front of block storage system
  - File “module” only supports one type of storage (Storwize V7000), not heterogeneous gateway
  - Virtualized external storage supported for file *but only for NFS access (not CIFS)*
  - Unified capability cannot be used with clustered systems
- Storwize V7000U is a single orderable system with block and file capabilities



© 2011 IBM Corporation

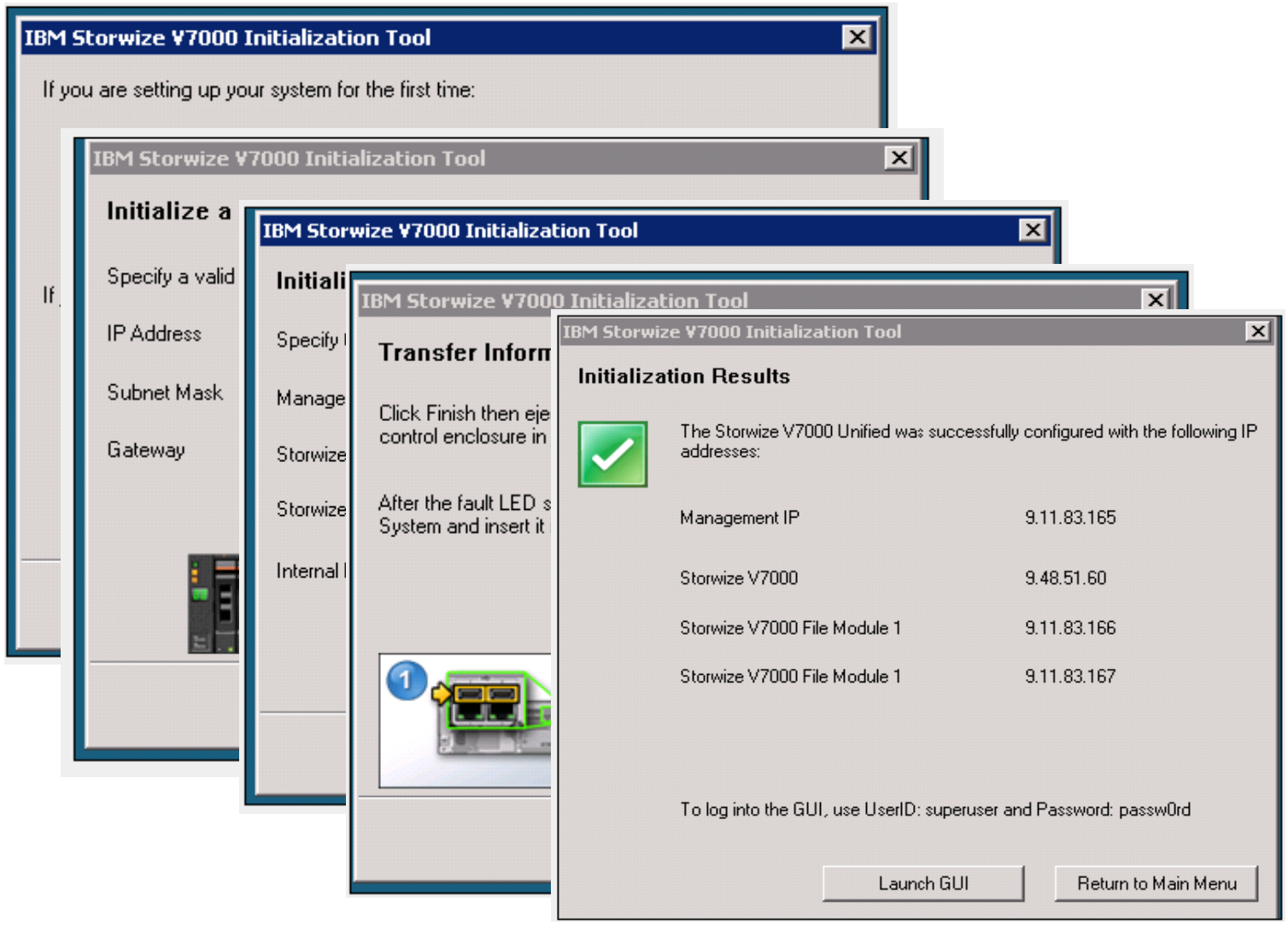
One system, one management framework, one GUI, one unified solution. Simple.

Because one > many.

© 2011 IBM Corporation

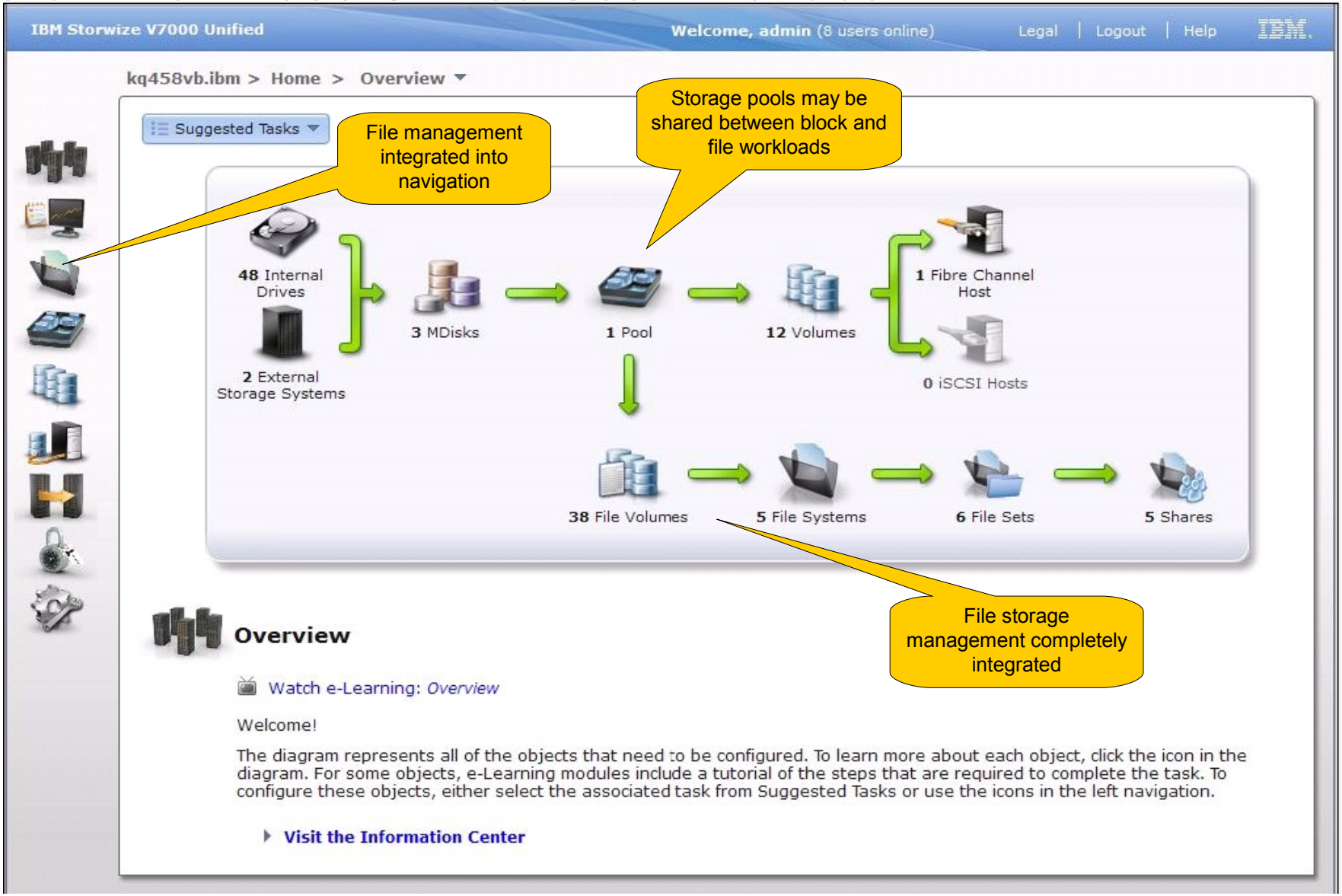
Storwize V7000 Unified: Designed for Easy Setup

Proven USB Key Approach Simplifies Setup for Unified System



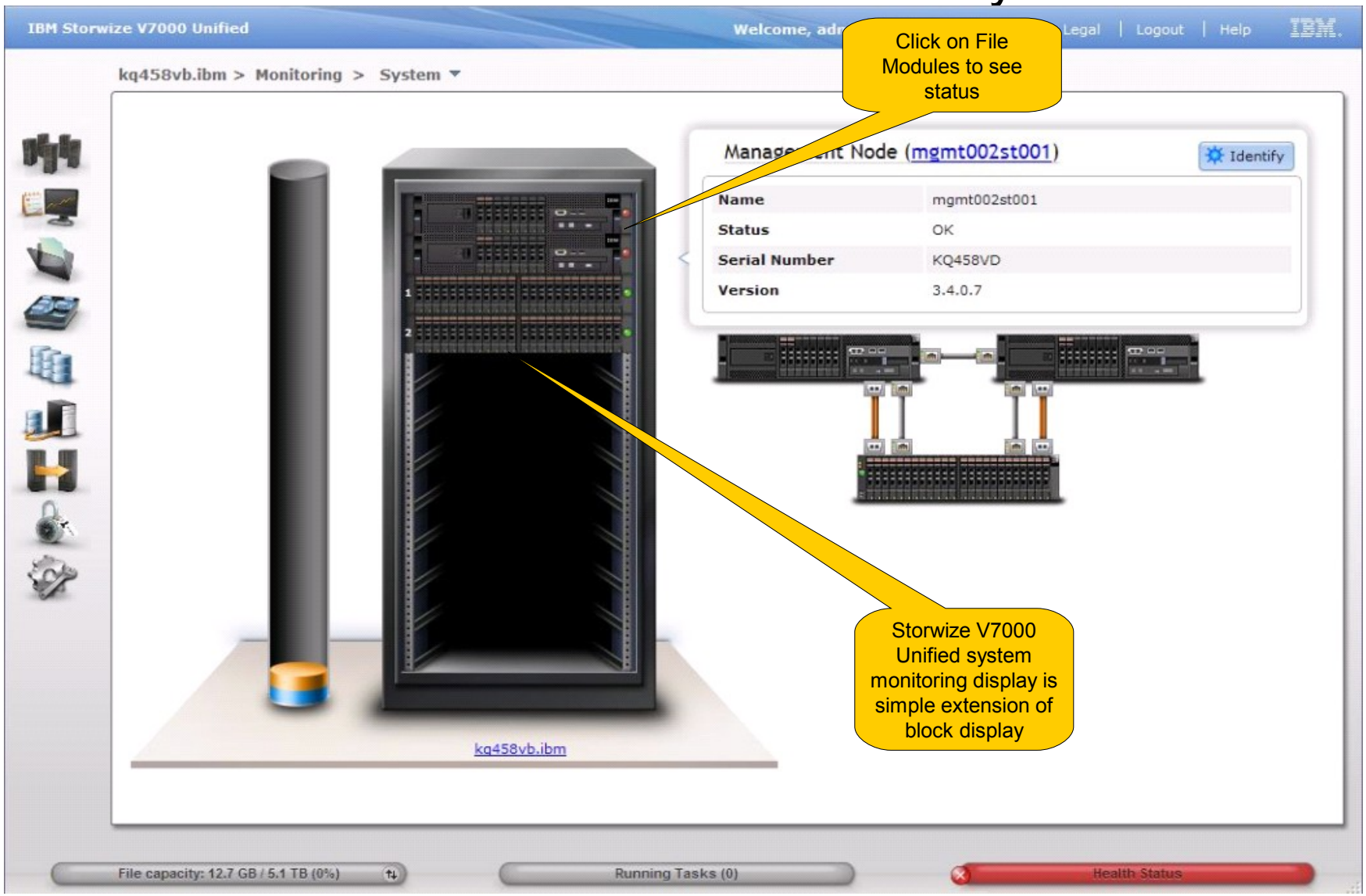
© 2011 IBM Corporation

Storwize V7000 Unified User Interface


IBM Storwize V7000 Unified
Welcome, admin (8 users online)
Legal | Logout | Help
kq458vb.ibm > Home > Overview
Suggested Tasks
File management integrated into navigation
Storage pools may be shared between block and file workloads
48 Internal Drives
2 External Storage Systems
3 MDisks
1 Pool
12 Volumes
1 Fibre Channel Host
0 iSCSI Hosts
38 File Volumes
5 File Systems
6 File Sets
5 Shares
File storage management completely integrated
Overview
Watch e-Learning: Overview
Welcome!
The diagram represents all of the objects that need to be configured. To learn more about each object, click the icon in the diagram. For some objects, e-Learning modules include a tutorial of the steps that are required to complete the task. To configure these objects, either select the associated task from Suggested Tasks or use the icons in the left navigation.
Visit the Information Center

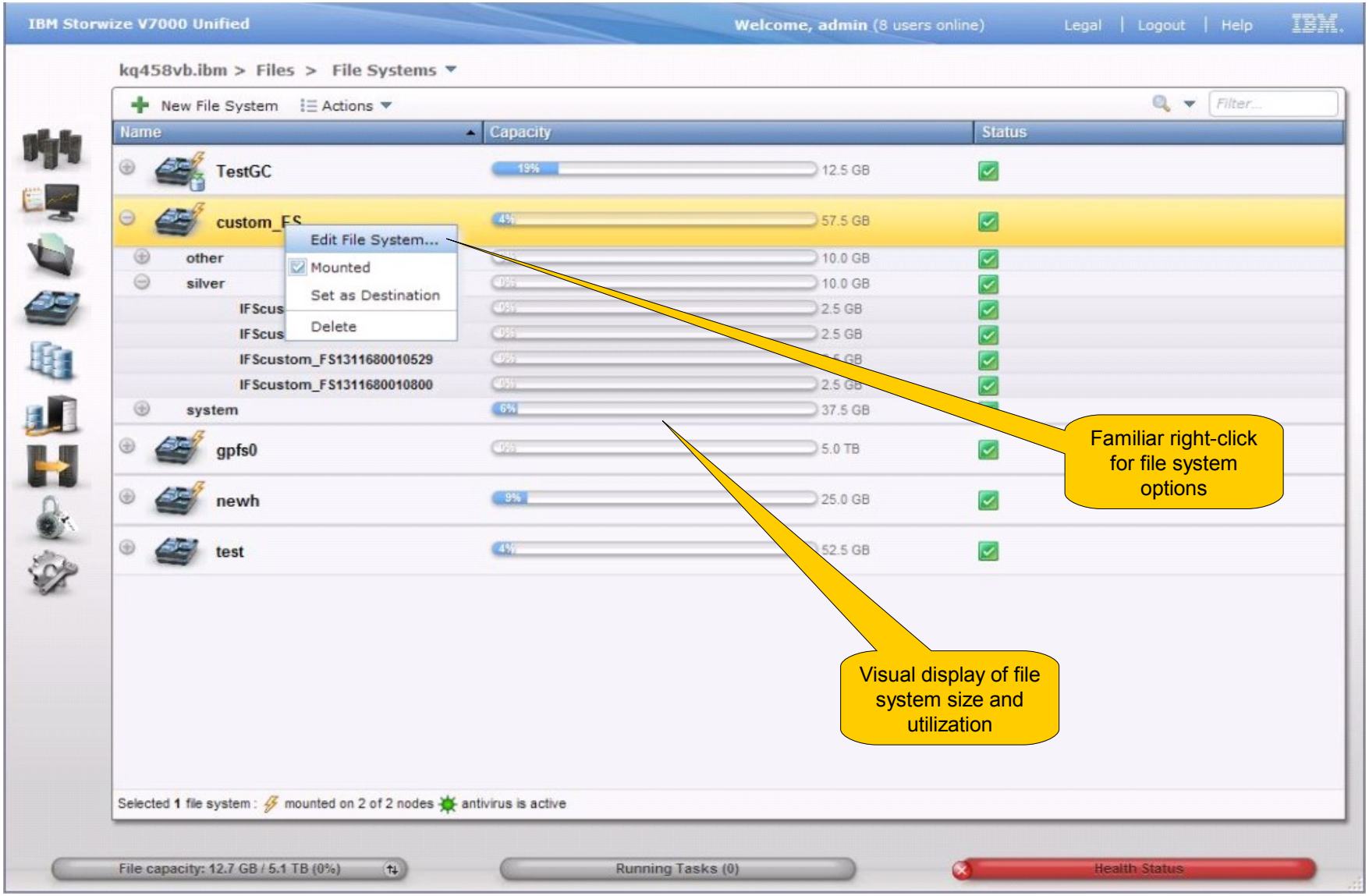
© 2011 IBM Corporation

Storwize V7000 Unified User Interface: System Status



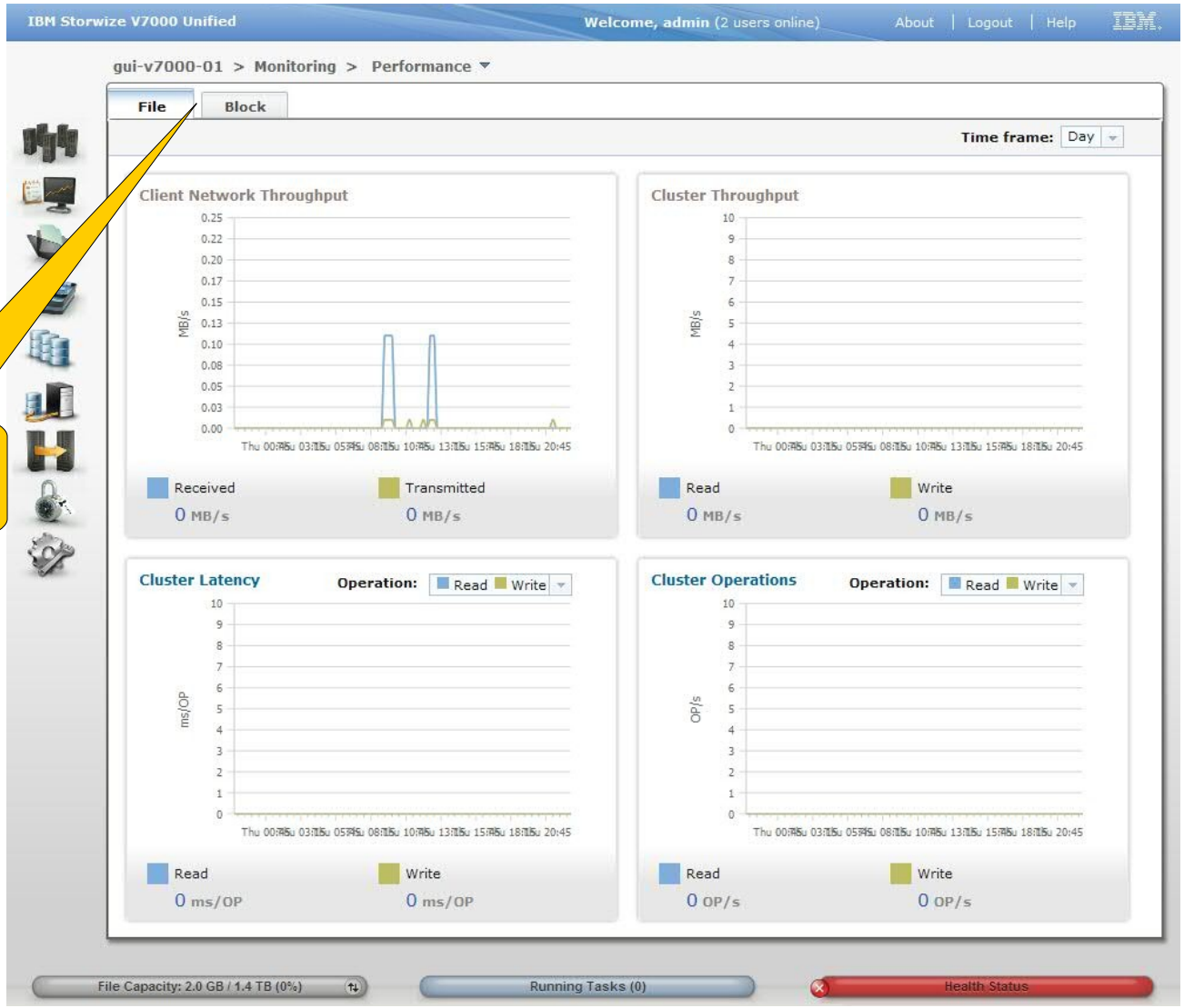
© 2011 IBM Corporation

Storwize V7000 Unified User Interface



© 2011 IBM Corporation

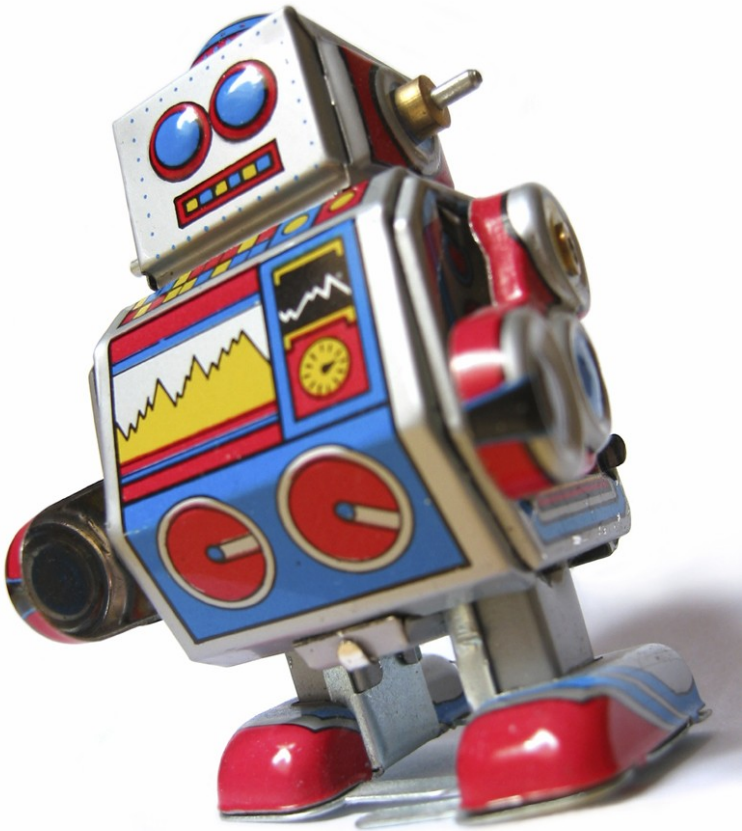
Storwize V7000 Unified User Interface



Switch easily between file and block performance display

© 2011 IBM Corporation

What is IBM Active Cloud Engine™ ? Think of it as a very smart, very fast robot – that never sleeps – keeping your cloud storage neat, tidy, and running smoothly…



© 2011 IBM Corporation

IBM Active Cloud Engine™ for Storwize V7000 Unified

- IBM Active Cloud Engine
  - Policy-driven engine that helps improve storage efficiency by automatically
    - Placing files when they are created on the appropriate storage
    - Moving files during their life to the right tier of storage including tape in a TSM hierarchy
    - Deleting expired or unwanted files
    - Identifying files for backup or replication to a DR location
  - High-performance: can scan large numbers of files very rapidly

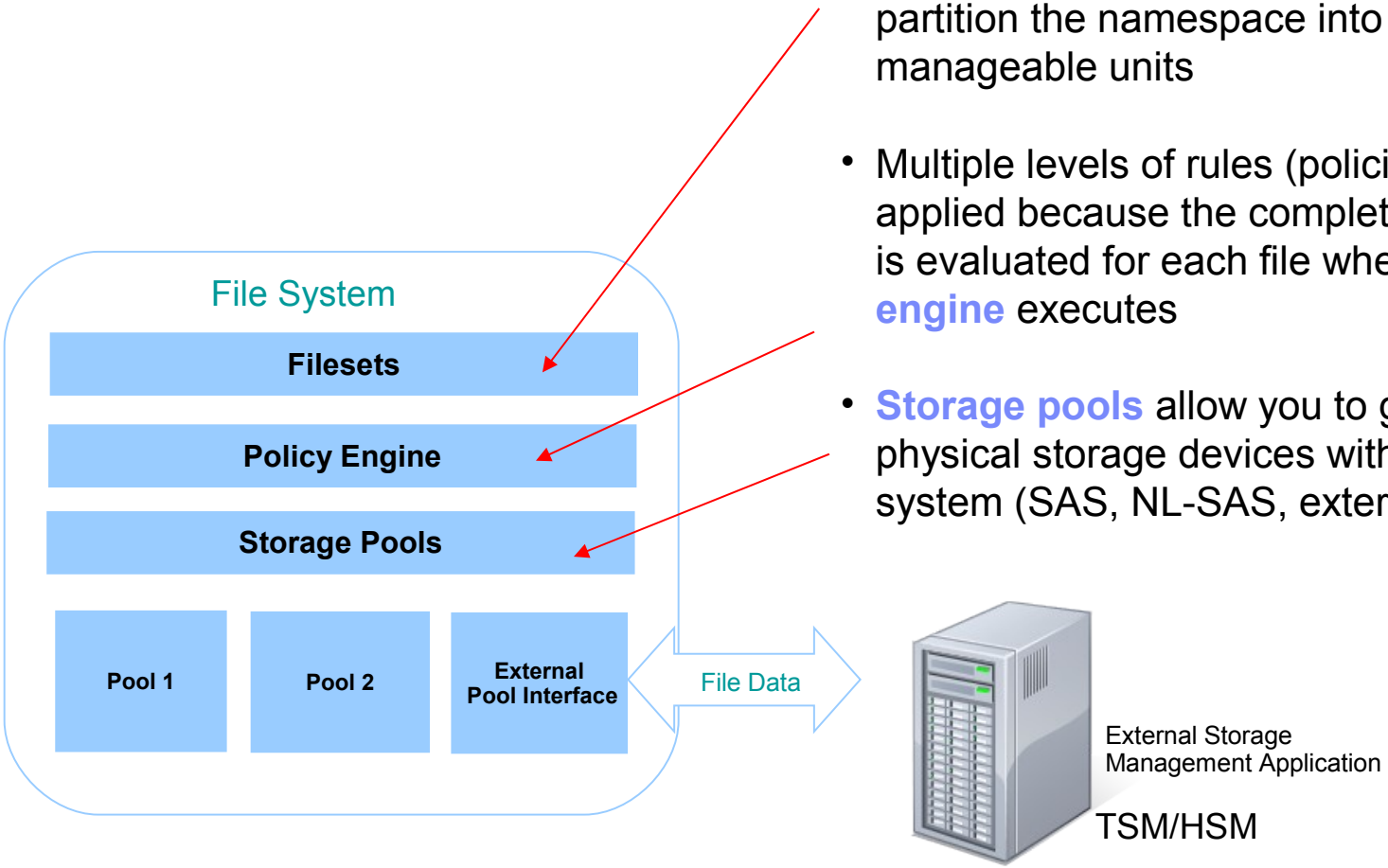
- IBM Active Cloud Engine Value
  - Lowers storage cost by moving files transparently to the most appropriate tier of storage
  - Controls storage growth by moving older files to tape and deleting unwanted or expired files
  - Enhances administrator productivity by automating file management
  - Improves data protection by identifying files for backup or DR

- Statement of Direction
  - *IBM intends to enhance Active Cloud Engine on Storwize V7000 Unified with the remote caching capabilities which are available starting with Active Cloud Engine in SONAS V1.3.0, which will provide multi-site remote caching capability to Storwize V7000 Unified and between SONAS and Storwize V7000 Unified*

© 2011 IBM Corporation

Understanding IBM Active Cloud Engine
Terminology

- A **fileset** is a logical subtree of the file system namespace and provides a way to partition the namespace into smaller, more manageable units
- Multiple levels of rules (policies) can be applied because the complete policy rule set is evaluated for each file when the **policy engine** executes
- **Storage pools** allow you to group multiple physical storage devices within a single file system (SAS, NL-SAS, external storage)



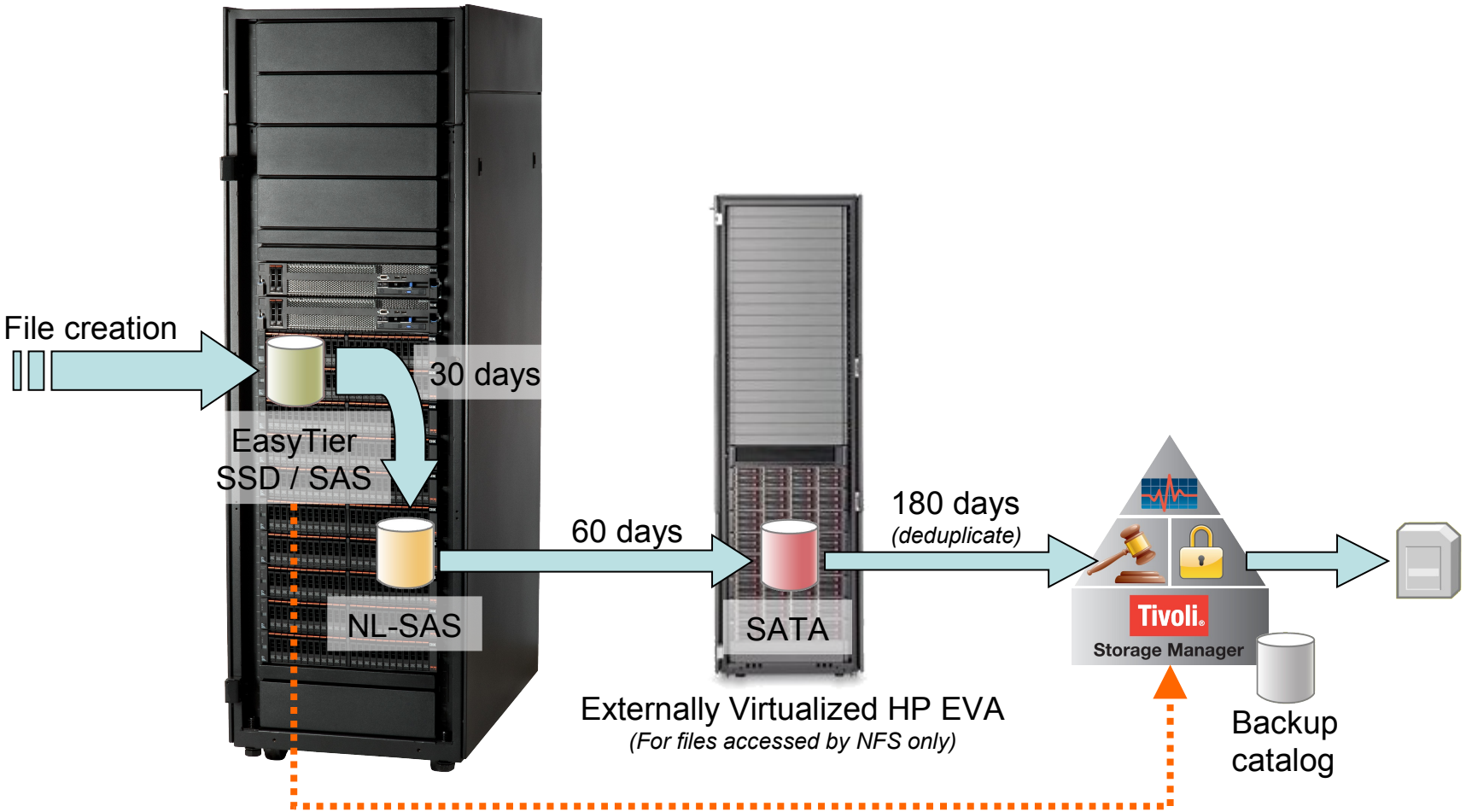
© 2011 IBM Corporation

IBM Active Cloud Engine Policies and Rules

- Active Cloud Engine supports two types of policies
- ***File placement policies***
  - Used to automatically place newly created files in a specific storage pool
  - Files in same fileset may reside on different storage pools
- ***File management policies***
  - used to manage files during their lifecycle
  - transparently move files to another internal or external storage pool
  - changing their replication status
  - Deletion
- Examples of policy rule uses
  - Initial file placement
  - File migration
  - Backup file data
- Characteristics that cause a rule or action to be executed
  - Last access time, last modification time, archive bit status
  - Fileset name, file name, extension, or file size
- Policy rules evaluated in order, from first to last, as they appear in the policy

© 2011 IBM Corporation

File Example Using Active Cloud Engine



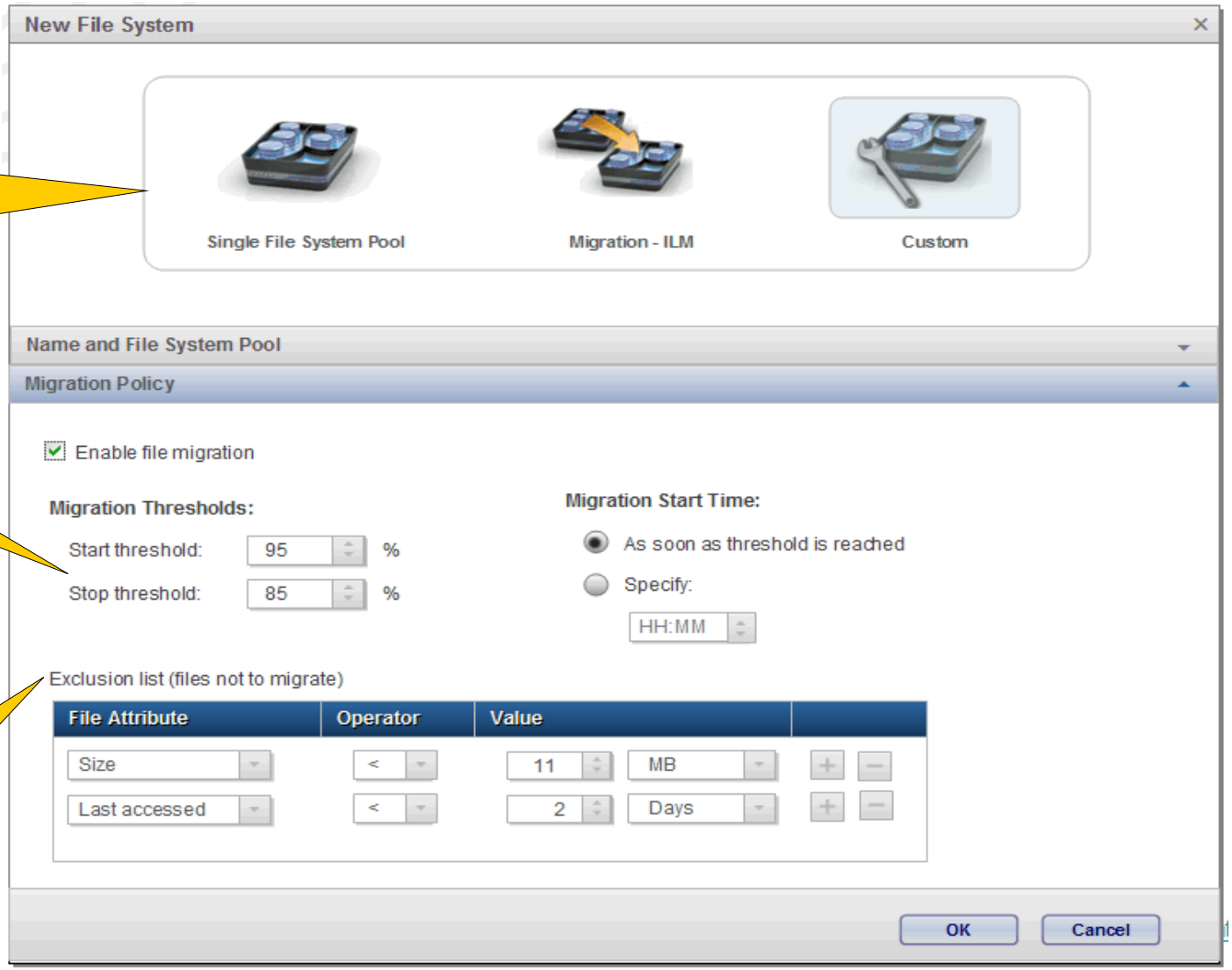
© 2011 IBM Corporation

Define Active Cloud Engine ILM Policies in the GUI

This dialog is modeled on the Storwize V7000 volume creation dialog

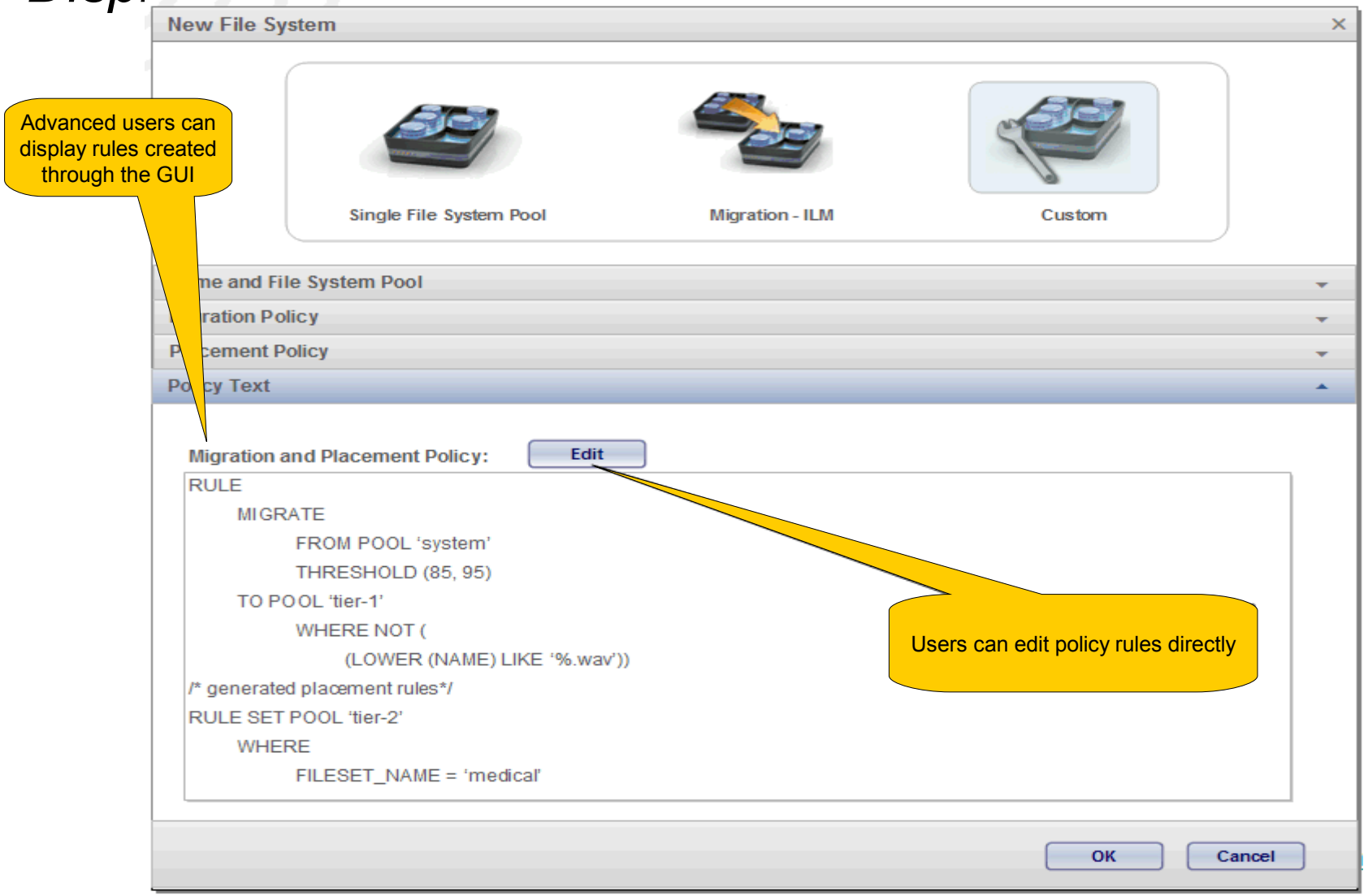
When to run this policy

Which files do *not* get migrated under this policy



© 2011 IBM Corporation

Define Active Cloud Engine ILM Policies in the GUI
Display and manually edit policy rules



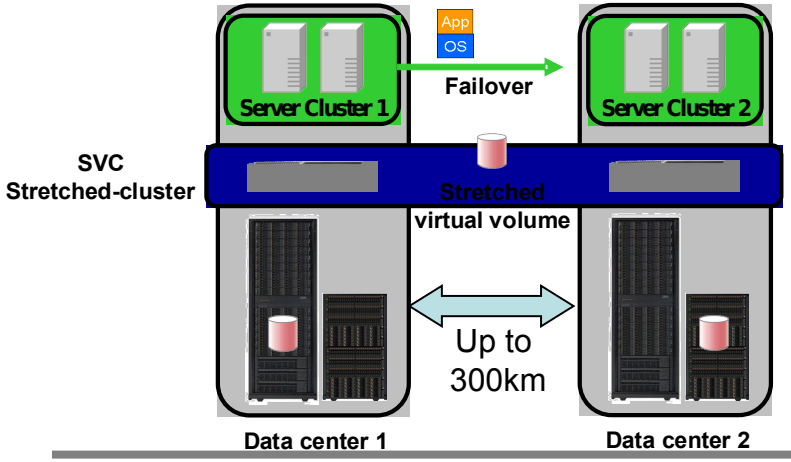
Advanced users can display rules created through the GUI

Users can edit policy rules directly

© 2011 IBM Corporation

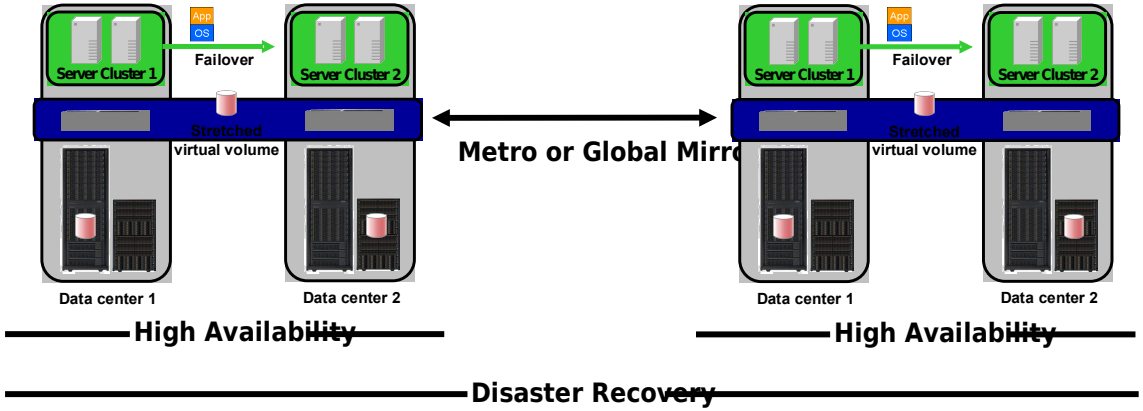
Improved Data Protection with SVC Enhanced Stretched Cluster

2-site Stretched Cluster



- Improve availability, load-balance, and deliver real-time remote data access by distributing applications and their data across multiple sites.
- Seamless server / storage failover when used in conjunction with server or hypervisor clustering (such as VMware or PowerVM)
- Up to 300km between sites (3x EMC VPLEX)

4-site Disaster Recovery



- For combined high availability and disaster recovery needs, synchronously or asynchronously mirror data over long distances between two high-availability stretch clusters.

© 2011 IBM Corporation

IBM Storage Portfolio as of 4Q2011

Entry/MidRange Storage Systems

- **Storwize Family**
  - V7000
  - V7000 Unified
- **DS Family**
  - DS5000
  - DS3000

Enterprise Storage Systems

- **DS8000 Family**
  - DS8700
  - DS8800
- **XIV Family**
  - XIV
  - XIV Gen3

File Storage Systems

- **Scale-Out NAS (SONAS)**
- **N Series**
  - N7000
  - N6000
  - N3000

Data Protection And Retention

- **TS Family**
  - TS7000
  - TS3000
  - TS2000
  - TS1000
- **ProtecTIER Deduplication**
- **Information Archive**

Efficiency "Enhancers"

- **Real-Time Compression**
- **Easy Tier**
- **SAN Volume Controller (SVC)**
- **Active Cloud Engine**

Storage Management Software

Tivoli software

- **FlashCopy Manager (FCM)**
- **Tivoli Productivity Center (TPC)**
- **Tivoli Storage Manager (TSM)**
- **Tivoli Key Lifecycle Manager**

© 2011 IBM Corporation

© 2011 IBM Corporation